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PATENT APPLICATION

Fuzzy Relations and Graph Structures for Compact Description and Modification

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Fuzzy Relations and Graph Structures for Compact Description and Modification

BACKGROUND OF THE INVENTION

The present invention relates to audio visual information systems, and more specifically to a system for describing , classifying, and retrieving audiovisual information for compact descriptions of relationships.

The amount of multimedia content available on the World Wide Web and in numerous other databases is growing out of control. However, the enthusiasm for developing multimedia content has led to increasing difficulties in managing accessing and identifying and such content mostly due to their volume. Further more, complexity and a lack of adequate indexing standards are problematic. To address this problem, MPEG-7 is being developed by the Moving Pictures Expert Group (MPEG) , which is a working group of ISO/IEC. In contrast to preceding MPEG standards such as MPEG-1 and MPEG-2 which relate to coded representation of audio-visual content, MPEG-7 is directed to representing information relating to content, and not the content itself.

The MPEG-7 standard, formally called the "Multimedia Content Description Interface" seeks to to provide a rich set of standardized tools for describing multimedia content. It is the objective to provide a single standard for providing interoperable, simple and flexible solutions to the aforementioned problems vis-à-vis indexing, searching and retrieving multimedia content. Software and hardware systems for efficiently generating and interpreting MPEG-7 descriptions are being developed.

More specifically, MPEG-7 defines and standardizes the following: (1) a core set of Descriptors (Ds)for describing the various features of multimedia content; (2) Description Schemes (DSs) which are pre-defined structures of Descriptors and their relationships; and (3) a Description Definition Language (DDL) for defining Description Schemes and Descriptors.

A Descriptor (D) defines both the semantics and the syntax for representing a particular feature of audiovisual content. A feature is a distinctive characteristic of the data which is of significance to a user.

As noted, DSs are pre-defined structures of Descriptors and their relationships. Specifically, the DS sets forth the structure and semantics of the relationships between its components having either Descriptors and/or Description Schemes. To describe audiovisual

content, a concept known as syntactic structure which specifies the physical and logical structure of audiovisual content is utilized.

The Description Definition Language (DDL) is the language that allows the creation of new Description Schemes and Descriptors. It also allows the extension and modification of existing Description Schemes. The DDL has to be able to express spatial, modification of existing Description Schemes. The DDL has to be able to express spatial, temporal, structural, and conceptual relationships between the elements of a DS, and between DSs.

Conventional systems have been unable to address the issue of weights for description schemes. A "weight" is a method of establishing the strength of a relationship between description schemes, representing properties or parts of a description. Disadvantageously, conventional systems place weights on entities themselves so that future changes to weights cannot be carried out in a simplified manner.

Therefore there is a need to resolve the aforementioned disadvantage and the present invention meets this need.

SUMMARY OF THE INVENTION

A method permitting compact ways to update relationships between entities in an audiovideo sequence, or serial set of sequences. The method comprises (1) writing a description between the entities, the description containing relations; (2) determining the relations that may be represented by parameters, each parameter having a numerical value; and (3) obtaining from the user, one or more of the following: (a) the numerical value for the parameter; (b) a description of the parameter containing the numerical value; and (c) a description capable of setting the parameter dynamically.

According to another aspect of the present invention, the method further comprises combining a State DS with an additional field in a GraphType DS.

According to another aspect of the present invention, combining allows a set of parameters to determine the strength of an edge, seen as a fuzzy member of the relation defined by edges on a set of vertices.

According to another aspect of the present invention, the method further comprises running, by a user, a query based on membership in the relation.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram of a technique for using the present invention.

Fig. 2 is block diagram of an alternate technique for using the present invention.

Fig. 3 is block diagram of an alternate technique for using the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The most concise method of offering a measure of the strength of a relationship, comes from examining the graph as a fundamental object. A graph is a set E of edges, a set V of vertices, together with a mapping $E \rightarrow V \times V$ specifying the start and end vertex for each edge. If this mapping is 1-1, then it the mapping specifies a subset of $V \times V$, if not, then it can be broken into a set of partial maps $\mathrm{E} \rightarrow V \times V$, which form subsets of $V \times V$ each on some subset of the set of edges. If n-ary relations are examined, the proper subsets of the proper Cartesian product space may be mapped, that is, the product space of the n spaces involved in the relation.

The simplest case considered here is as follows. The form of E is a relation on the set V of vertices. As such the above mapping may be viewed as an inclusion, to produce $E \subseteq V \times V$. Giving E as a subset, allows the proper framework to evaluate measures of strength, by measuring the degree to which a particular edge is a member of E. This establishes a membership function $m_E : V \times V$, giving both a way of specifying strength or confidence in a relationship, and a simple mechanism for achieving it. () This definition of a fuzzy relation differs from the conventional definitions which defines a relationship on the whole Cartesian product, whereas the present invention defines fuzzy relationship on a subset This is of great advantage in writing concise descriptions, since we use the lack of a relation to abbreviate the Graph written, and this is formally equivalent to the relation having the membership function value of zero. It also preserves the ability to make Boolean queries on the structure of the graph, where otherwise we are limited to complete graphs (graphs with edges between each n nodes). The definition is beneficial in parametrized membership functions below, because the parametrization function is then an implicit function.

The very simplest technique for "fuzzifying" graphs is to allow that the membership function is defined for the graph relation itself in one step. In practical terms this involves adding a weight attribute to each Edge in a graph, or Link outside a graph. The problem with this is that all of the mechanisms for updating the value of an edge in an interactive or streaming environment is now implicit. It is possible to have the calculations for the membership function be more explicit, by using the State DS.

In reality, the relation E on $V \times V$ is part of a decomposition involving entities which are represented by the vertices in V, and the various and sundry relationships in which they are involved. This decomposition maps the description on to all the relations of which any part participates. When a relationship is written in Graph DS, a relation $R \subseteq A \times B$, is being formed, after which R is mapped into E as a subset. The values which determine the membership function value in E are therefore parameters affecting the entity types A and B, and the relation R which maps into the graph.

This suggests use of a parametrized membership function. This means that if R is a fuzzy set, and x is an element, we split the mapping via a parameter space, PS, that is, defining $m_R(x)$ by defining $f : A \times B \to PS, g : PS$, and $m_R(x) = g \circ f(x)$. How this works is that we define, the relation R, as a "relation type". In the relation type, we define the parameter function g, leaving the parametrization function f to be defined implicitly when edges are defined. Suppose, for an example, that we have $g(u + v + t + w) = (u + v + t + w)/4$, u, v, t, w reals(double)constrained. Define a graph with an Edge(a,b), and a State DS with attribute-value pairs these 4 variables, and a Link to Edge(a,b) (or from Edge(a,b) if the scoping is easier).

As the AV sequence progresses through time, the values of these variables are updated and this changes the confidence in this edge. The dependencies of the membership function on parameters are expressed in the membership function declaration. Since these are attribute value pairs, it is also possible to link to the attributes in the two or more nodes participating in the relation instance. This circumstance is likely to be common, it asserts that the participants in a relation determine the level of that relation.

Figs. 3 above of the ripe fruit illustrates this usage. The use of this is for "running descriptions", like live feeds. Fig. 1 is a block diagram of a technique for using the present invention. In Fig. 1, a member function expressed in the Relation DS is shown.

Fig. 2 is block diagram of an alternate technique for using the present invention. In Fig. 2, a member function expressed by a SemanticStateDS is shown.

Concretely, define each as the "temperature" of 4 romantic relationships a certain unfaithful husband in the soap opera "The Coming Storm" is engaged in. Let Edge1(a,b) be an edge in the graph of the relations between all characters in "The Coming Storm", a is the husband, b is his wife, and Edge1 is an element of the relation (i.e. an instance of the relation type) "isn't honest with". The state is the only element in this simple

scenario that needs to be updated to give soap opera fans who missed the show a rundown on how the main marriage in “The Coming Storm” is doing.

Syntax:

The following gets added to GraphType.

```
<complexType name=MemberFunction>
    <attribute name=“id” type=“ID” use=“optional” />
    <attribute name=“parameter” type=“AttributeValuePair”
    minOccurs=“0” maxOccurs=“unbounded” />
    <attribute name=“functionType” type=“ControlledTerm” />
    c/complexType>
```

Therefore, the present invention uses the State DS combined with an additional field in GraphType that allows a set of parameters to determine the strength of an edge, seen as a fuzzy member of the relation defined by edges on the set of vertices. This is shown to allow compact ways to update relationships between entities in an audiovideo sequence, or serial set of sequences.

While the above is a complete description of exemplary specific embodiments of the invention, additional embodiments are also possible. Thus, the above description should not be taken as limiting the scope of the invention, which is defined by the appended claims along with their full scope of equivalents.